

Characteristics of Chemical and Nuclear Reactions	
Chemical Reactions	Nuclear Reactions
Occur when _____ are broken and formed.	Occur when nuclei emit _____ and/or _____.
Atoms remain unchanged, though they may be _____.	Atoms are often _____ into atoms of another element.
Involve only _____ or the outermost electrons.	May involve _____, _____, and _____.
Associate with _____ energy changes.	Associated with _____ energy changes.
Reaction _____ is influenced by temperature, pressure, concentration, and catalysts.	Reaction rate is _____ affected by temperature, pressure, or catalysts.

**Radioactivity and Radiation**

\_\_\_\_\_ or \_\_\_\_\_ is the process by which some substances spontaneously emit radioactive rays and particles. Radioactive isotopes (atomic number > \_\_\_\_\_) have unstable \_\_\_\_\_ and decay spontaneously. Other nuclei are unstable because of \_\_\_\_\_. An unstable nucleus decays to become more stable, resulting in:

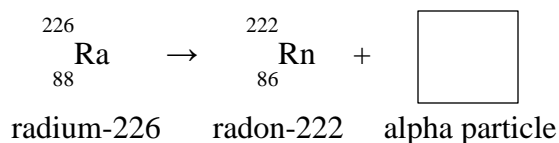
- 1) \_\_\_\_\_, and
- 2) \_\_\_\_\_.

**Types of Radiation and Decay**

Types of Radiation						
Type	Emission	Composition	Symbol	Charge	Mass	Penetrating Power
Alpha decay						
Beta decay						
Gamma emission						

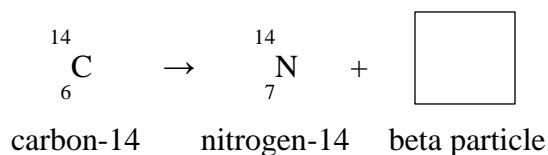
1. Unstable nuclei with more than 83 protons undergo \_\_\_\_\_, emit an \_\_\_\_\_, and decrease the number of \_\_\_\_\_.

**Example:** Nuclear equation for the alpha decay of radioactive radium-226 to radon-222:



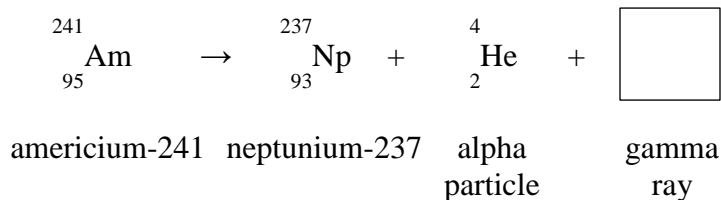
2. Radioisotopes with too many \_\_\_\_\_ undergo \_\_\_\_\_, emit an \_\_\_\_\_, and decrease the number of \_\_\_\_\_.

**Example:** Nuclear equation for the beta decay of carbon-14 into nitrogen-14:



3. Gamma emission involves releasing \_\_\_\_\_ but does not create new \_\_\_\_\_ alone.

**Example:** Gamma rays accompany alpha and beta decay processes:

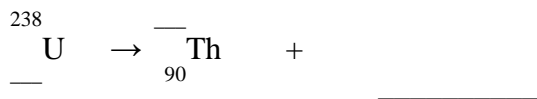


## Balancing Nuclear Equations

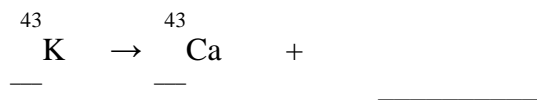
Nuclear \_\_\_\_\_ are written to express nuclear \_\_\_\_\_. Isotopic notation is used to show that \_\_\_\_\_ numbers and \_\_\_\_\_ numbers of the involved particles are conserved.

1. Balance the number of nucleons (\_\_\_\_\_) using mass number.
2. Balance the charge using atomic number.
3. Determine the decay product (alpha or beta particle) and write the balanced equation.

**Example 1.** Write a balanced equation for the decay of uranium-238 to thorium-234.



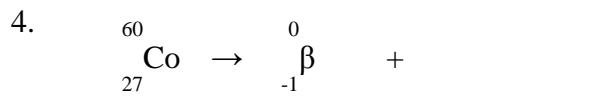
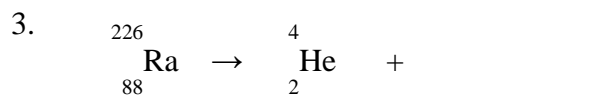
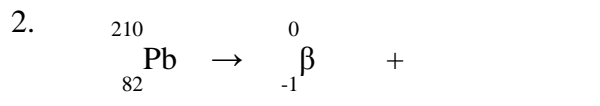
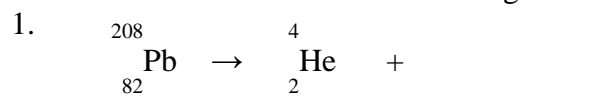
**Example 2.** Write a balanced equation for the decay of potassium-43 to calcium-43.



**Practice Set 1.** Write the balanced equation for the following nuclear reactions.

1. Uranium-233 undergoes alpha decay
2. Copper-63 undergoes beta decay
3. Beryllium-9 and an alpha particle combine to form carbon-13
4. Phosphorus-32 and a neutron combine to form phosphorous-33

**Practice Set 2.** Balance the following nuclear equations.



### Nuclear Fission

In nuclear fission, the heavy nucleus of an atom is bombarded by a \_\_\_\_\_ and splits into \_\_\_\_\_. The new isotopes formed emit \_\_\_\_\_, which can be used to split other nuclei. This process continues forming a \_\_\_\_\_. The explosion from an atomic bomb results from an \_\_\_\_\_ chain reaction.

### Nuclear Fusion

The process by which two small nuclei combine to form a larger, more stable nucleus is nuclear \_\_\_\_\_. Nuclear fusion releases more energy than nuclear \_\_\_\_\_, but extremely high energies and temperatures are required to initiate and sustain fusion reactions. The \_\_\_\_\_ are powered by fusion reactions. All elements heavier than \_\_\_\_\_ are formed through nuclear fusion.

## Half-Life

Radiochemical \_\_\_\_\_ is the process of determining the age of an object by measuring the amount of a certain radioisotope that remains. This process is possible because the decay rates of radioactive nuclei are \_\_\_\_\_ and are referred to as the \_\_\_\_\_ of the radioisotope.

**Half-life** defined:

\_\_\_\_\_ is used in radioactive dating for specimens that are less than 20,000 years old and were once living. \_\_\_\_\_ has been used to date ancient rocks and minerals.

## Half-Life Problems

Half-life problems may be solved using a mathematical formula or a step-by-step table.

Two formulas:

where $n =$
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where $t =$ and $T =$
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**Example:** The half-life of strontium-90 is 29 years. If you had 100. g today, how much Sr-90 would remain in 116 years? ( $t =$  \_\_\_\_\_ and  $T =$  \_\_\_\_\_)

How many half-lives ( $n$ ) will have passed in 116 years?

# of Half-lives	Time Passed	Amount Remaining